CLAIMS

What is claimed is:

1. A method for fabricating nano-scale structures, the method comprising the steps of:

a) providing a substrate having a surface;

b) depositing a nutrient medium on the surface of the substrate;

c) introducing microbes onto the nutrient medium;

d) growing elongated microbes to form oriented sacrificial mandrels;

e) optionally removing a portion of the nutrient medium;

f) coating each oriented sacrificial mandrel with an outer layer of a desired nano-tube material; and

g) removing the sacrificial mandrels, while leaving oriented nano-tubes.

2. The method of claim 1, wherein the surface of the substrate comprises a material on which the microbes cannot grow.

3. The method of claim 1, wherein at least the step c) of introducing and the step d) of growing microbes are performed in an environment substantially free of undesired organisms.

4. The method of claim 1, wherein at least the step c) of introducing and the step d) of growing microbes are performed in an environment having illumination controlled to be suitable for microbial growth .

5. The method of claim 1, wherein the step c) of introducing and the step d) of growing microbes are performed in an environment having temperature controlled within a range suitable for microbial growth.

6. The method of claim 1, wherein the elongated microbes are generally cylindrical.

7. The method of claim 1, further comprising the step of:

h) patterning the nutrient medium to form a multiplicity of nutrient islands spaced apart from each other.

8. The method of claim 7, wherein the step h) of patterning the nutrient medium is performed before the step c) of introducing microbes onto the nutrient medium.

9. The method of claim 7, wherein the elongated microbes are generally cylindrical.

10. The method of claim 9, wherein the generally cylindrical microbes have a characteristic diameter, and wherein the step h) of patterning the nutrient medium includes forming islands having at least one lateral dimension greater than or equal to the characteristic diameter of the generally cylindrical microbes.

11. The method of claim 1, further comprising the step of:

i) coating each sacrificial mandrel with an intermediate layer of polymer before performing the step e) of coating each oriented sacrificial mandrel with an outer layer of a desired nano-tube material.

12. The method of claim 1, wherein the step g) of removing the sacrificial mandrels is performed in vacuum.

13. The method of claim 1, wherein the step g) of removing the sacrificial mandrels is performed by wet etching.

14. The method of claim 1, wherein the step g) of removing the sacrificial mandrels is performed by plasma etching.

15. The method of claim 14, wherein the plasma etching is performed by using an oxygen plasma.

16. The method of claim 1, wherein the steps are performed in the order recited.

17. An array of nano-tubes, fabricated by the method of claim 1.

18. An integrated circuit, fabricated by the method of claim 1.

19. A method for fabricating nano-scale structures, the method comprising the steps of:

a) providing a substrate having a surface on which microbes cannot grow;

b) providing an environment substantially free of undesired organisms;

c) depositing and patterning a nutrient medium on the surface of the substrate to form a multiplicity of nutrient islands spaced apart from each other;

d) introducing microbes or propagules thereof onto the nutrient medium;

e) growing elongated generally cylindrical microbes to form oriented sacrificial mandrels;

f) optionally removing a portion of the nutrient medium;

g) coating each oriented sacrificial mandrel with an intermediate layer of polymer and an outer layer of a desired nano-tube material; and

h) removing the sacrificial mandrels and the intermediate layer of polymer, while leaving oriented nano-tubes.

20. The method of claim 19, wherein the steps are performed in the order recited.

21. An array of nano-tubes, fabricated by the method of claim 20.

22. An array of nanostructures, comprising:

a multiplicity of nanostructures disposed in a predetermined pattern on a substrate, the nanostructures being oriented in a predetermined orientation, and the nanostructures being characterized by interior dimensions commensurate with the dimensions of predetermined microbes.

23. A method of using microbes to form nano-tubes, the method comprising the steps of:

a) providing a substrate having a surface;

b) depositing a nutrient medium on the surface of the substrate;

c) introducing microbes or propagules thereof onto the nutrient medium;

d) growing elongated microbes to form oriented sacrificial mandrels;

e) optionally removing a portion of the nutrient medium;

f) coating each oriented sacrificial mandrel with an outer layer of a desired nano-tube material; and

g) removing the sacrificial mandrels, while leaving oriented nano-tubes.

24. The method of claim 23, wherein the steps are performed in the order recited.

25. An array of nano-tubes, fabricated by the method of claim 23.

26. A nano-scale structure carried by a substrate, the nano-scale structure comprising:

a) an elongated microbe having first and second ends, the microbe being affixed to the substrate at its first end;

b) a polymer coating covering the elongated microbe; and

c) an inorganic coating covering the polymer coating.

27. The nano-scale structure of claim 26, wherein the inorganic coating comprises a conductor.

28. The nano-scale structure of claim 26, wherein the inorganic coating comprises a semiconductor.

29. The nano-scale structure of claim 26, wherein the inorganic coating comprises an insulator.

30. A nano-scale structure formed by removing the microbe of the nanostructure of claim 26.

31. A nano-scale structure formed by removing the microbe and polymer coating of the nanostructure of claim 26.

32. An array of nano-scale structures comprising a multiplicity of the nanostructures of claim 31.

33. An array of nano-scale structures comprising a multiplicity of the nanostructures of claim 26.

34. A mandrel fixture for fabricating a nano-scale structure carried by a substrate, the mandrel fixture comprising in combination:

a) means for supporting and orienting the nano-scale structure relative to the substrate, the means for supporting and orienting being microbial; and

b) means for stiffening the microbial means for supporting and orienting the nano-scale structure.